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Abueg, Luisito

University of the Philippines Los Baños

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A survey of the ocean's plastic waste problem, and some policy developments of the Philippines

Luisito C Abueg¹

**Assistant Professor, Department of Economics
University of the Philippines Los Baños**

Abstract

A review of literature the state of ocean clean-up and how is the Philippines contributing to problem of plastic disposal globally. This paper focuses on the problems related to the generation, use, and disposal of single-use plastics. This also presents a review on recent policy formulation and implementation in addressing such problems, both on the level of local government units and the national key agencies. Anecdotal examples of business initiatives are also cited in literature review.

Keywords: plastics, single-use refuse, ocean clean-up, ocean pollution, ocean garbage patches, plastic use bans, recycling, Philippine environmental laws, solid waste management

¹ Former graduate Fellow (PhD Economics), School of Economics, University of the Philippines Diliman (UPSE), and currently an Assistant Professor, Department of Economics, College of Economics and Management, University of the Philippines Los Baños. Email: lcabueg@up.edu.ph. Review of literature from materials on papers submitted in graduate courses in Public Economics (Economics 251), and Natural Resource and Environment Economics (Economics 275). The author would like to thank Dr Agustin Arcenas and Dr Orville Jose C Solon (UPSE), Mr Rafael Martin Consing III, Mr Antonio Jose Lumba, and Mr Michael Barsabal (UPSE graduate students), and Dr Anna Lou Abatayo (Bocconi University, Italy) and for their comments in improving this work. The author is also grateful to the comments and suggestions raised during the presentation in the parallel session on Energy and Environmental Efficiency in the 43rd Federation of ASEAN Economic Associations (FAEA) on 10 November 2018 at Novotel Manila Araneta Center.

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Oceans have become one of the recent focus on problems on environmental degradation in recent decades. More particularly, as demand for goods and services continuously pressure environmental limits, more and more waste is produced, of which the oceans become the receiving end of waste and byproducts that harm the environment.

One of these byproducts of modern technology and methods of production is the invention of plastics, which has become pervasive in almost all aspects of modern human life. Perhaps, the discovery and use of plastics have been one of the features of the mass production of the twentieth century, since the Industrial Revolution.²

However, plastics take more time to disintegrate, relative to average human lifespan. The continuous accumulation exacerbates the problem, and such plastic products usually end in oceans. For example, common plastic articles such as single-use plastic bags and bottles may require more or less 500 years to disintegrate (Gorman [1993], cited in Derraik [2002]). Jambeck, et al. (2015), have also provided some trends in plastic production globally given this technological innovation:

Plastics have become increasingly dominant in the consumer marketplace since their commercial development in the 1930s and 1940s. Global plastic resin production reached 288 million MT in 2012, a 620% increase since 1975. The largest market sector for plastic resins is packaging³; that is, materials designed for immediate disposal. In 1960, plastics made up less than 1% of municipal solid waste by mass in the United States⁴ (4); by 2000, this proportion increased by an order of magnitude. By 2005, plastic made up at least 10% of solid waste by mass in 58% (61 out of 105) of countries with available data⁵.

Much of the plastic waste have been produced in Asia of which the Philippines⁶ is the third highest contributor globally, relative to the 120 countries covered, obtaining data estimates on plastic waste generation (Jambeck, et al. [2015]). A projection reported in the World Economic Forum (Pennington [2016]) stressed that of the 78 million tons of plastic produced every year, only 14% are recycled, and 32% end up in the oceans. This is even supported by estimates of Geyer, Jambeck, and Law (2017), saying that if such trend of plastic waste generation continues, an approximate volume of 12,000 metric tons of plastic waste material will be generated by the whole world, of which much will

² A comprehensive timeline on the history of plastics can be obtained by BPF (2014).

³ From Plastics Europe (2013).

⁴ From US EPA (2011).

⁵ From Hoornweg, and Bhada-Tata (2012).

⁶ The month of May, aligned with the paper's submission and presentation is regarded as the Month of the Oceans, per President Joseph Estrada's proclamation 57 signed 11 December 1998 (Inquirer Research [2018]).

end into the oceans. Pennington (2016) further suggests that if the current rate of plastic waste production continues, the world's oceans could have more plastic wastes than the total fish population.

A similar projection was also discussed in an article in *The Economist* (2015), claiming that the world is generating already 1.4 trillion single-use plastic bags each year. While growth is an economic objective, the accumulation of such residuals and wastes have been regarded as "bad growth" for the economy (Barnes [2016]). Another estimate reported in the *National Geographic* indicated that 91% of the world's generated plastic material are not being recycled (Parker [2018]).

A recent report by Global Alliance for Incinerator Alternatives (GAIA [2019]), a nongovernment organization, estimated that apart from single use plastic bags (either shopping bags or thin-film bags), plastic sachets contribute more to the plastic waste generation of the Philippines. They have estimated that on the average, The Philippines generate 163 million pieces of plastic sachets (from their data audit in 2016 used in the study), which can cover the whole land area of Metro Manila in one foot deep of plastic waste.

Given the above situation, this paper tries to look at the various perspective of measures addressing plastic waste accumulation. We also discuss ocean clean-up from a perspective of public economics: the oceans being a global public good. We will also run through in this survey some of the possible insights from the issues addressed by policies targeted to abate plastic accumulation in oceans in the Philippines.

Types of and pathways of plastic waste transport

Plastics vary in form, durability, and degree at which it readily degenerates: the durable versus the disposable plastics, and the microplastics (smaller particles of plastics that can be digested by marine animals and other marine species) and nanoplastics (e.g., microbeads, and synthetic fibers). Disposable plastics includes single-use plastic bags, which is usually being blamed for the increase in plastic waste in the oceans. Durable plastics are those plastics that require longer time for them to decompose, while the disposable ones are those plastics mixed with organic components for them to easily degenerate (example is the use of corn fiber in the production of plastics being used in wet markets). A popular example of a durable plastic product being used today that potentially contributes to plastic waste generation is the polyethylene terephthalate (PET) In this survey, the plastic materials discussed are that of the PET, and the single-use plastics.

Plastics⁷ have become a convenient material for packaging, transport, storage of goods, as well as substitute material for the production of a lot of human related-implements (e.g., in the household, manufacturing, medical, cosmetics).

Recognizing the concerns about increasing solid waste accumulation, the Philippines has responded through legislation. Apart from these legislations, there are also some significant movements from advocacy groups, nongovernment organizations, and individual initiatives, that support environmental quality improvement, particularly on reduction of plastic waste generation.

Accumulation of Plastics in Oceans

Oceans as global public goods⁸ are shared by at least two countries or areas, in which the properties of public goods (nonrival and nonexcludable) extend beyond political borders. The water quality, fishery production, and biodiversity preservation from oceans as global public goods are shared and benefitted by different political territories. This aspect of oceans providing benefits across various political domains brings the open-access that is prone to the problem of the “tragedy of the commons” (Hardin [1968]).

Wright, et al. [2013] shows a pathway of transport of plastic waste into the oceans and other bodies of water. In addition, plastic waste accumulation have been found to pose serious threat to marine habitat such as coral reefs (Caruana [2018]).

The problem of clean-up is when some countries contribute to plastic accumulation through their economic activities, or from the manner in which environmental laws are created and implemented. To some extent, it may be possible that some territories have deliberately used oceans as receptors of solid waste. However, oceans cannot be treated as water bodies that simply absorb plastics generated from the continuous economic activities.

In addition to accumulation of plastic waste into bodies of water and the relatively slow decomposition rates of plastic waste products, the pollution from plastics is exacerbated by “ocean currents” that create “garbage patches” of nonbiodegradable material. A particular case is Great Pacific Garbage Patch, located between California and Hawai’i, which has been monitored and shown significant increases in plastic waste accumulation in recent years (Lebreton, et al. [2018]). Apart from the Great Pacific Garbage Patch, there are other garbage patches identified by marine experts studying ocean currents.

⁷ The classification of the Society of the Plastics Industry of the seven most commonly used plastic products can be found in the document of the Riyedale District Council, United Kingdom [2012].

⁸ Abatayo, et al. [2017] called these global public goods as “transnational public goods”, which are enjoyed across political borders.

Scientists using advanced remote sensing technology, have monitored the rate of accumulation and spread of these garbage patches. Sainte-Rose, et al. (2016) devised a model that determines the extent of which ocean plastics accumulate in identified garbage patches and the clean-up efforts being done. With this information, scientists feed information to on the extent of such damages caused by the accumulation of plastics in the oceans.

Studies show that plastic accumulated in water bodies and ultimately into the oceans come from nonpoint sources. Households are major nonpoint sources which are more difficult to monitor relative to point sources (usually firms) that are subjected to government regulation and control (Perman, et al. [2003]).

Plastics accumulation in oceans have environmental, biological, chemical side effects such water quality declines affecting marine biodiversity. There are also documented cases of marine species entangled with this plastic waste⁹ (e.g., Parker [2018]). Plastics are deterrent to physical growth, causes formation of physical deformities) and cause intoxication or suffocation, or even death - ocean organisms mistake plastics as food (Wright, et al. [2013]). There are also studies documenting health effects on marine organism of accumulation of these marine litter (Galloway [2015]; Kühn, et al. [2015], cited in Newman, et al. [2015]) consequently affecting humans when marine species are harvested for food.

Given the nature of the oceans being open-access resources there must be a mechanism in place necessary for affected territories affected by plastic waste accumulated in oceans. Such mechanism may involve some form of bargaining or a set of agreements between these affected parties.

The Coasean solution to Ocean Plastic Accumulation

With the oceans being open access and plastic wastes generating negative externalities, we revisit the approach of bargaining under certain necessary conditions, attributed to Ronald Coase. Coase (1960) has provided a bargaining solution in the presence of externalities being generated from an economic activity affecting at least one party. The Coasean solution (popularly known as "Coase theorem") hypothesizes that transactions costs between parties are very low (zero or negligible) under a perfectly competitive market environment. However, the Coasean solution works only in small groups that are bargaining for some reduction in [negative] externalities emanating from a particular economic activity. Such is not the case if bargaining groups become relatively large, or the geographical scope increases (in this case, global in scope). This presupposes that monitoring can be strictly enforced and there is perfect information between parties. In real-world situations involving externalities from

⁹ A good listing of cases of plastic pollution affecting marine species as well as some species of birds and mammals depending on oceans may be found in Derriak (2002).

economic activities (that affect the environment), there is always information asymmetry between parties involved. This is made even worse by the fact that some information is private to particular individuals or groups, or the effects of such negative externalities cannot be quantified or measured readily.

Another problem is information needed on proper solutions to apply to plastic waste generation is that measuring impacts of the accumulation of these marine litter is by no means direct. This is highlighted in Newman, et al. (2015), saying that there are unobservables in terms of the intangible and time-bound effects to the environment in general, and to the countries or areas in particular. This missing information creates asymmetry to some extent, unintentionally due to the nonmeasurability of these factors. This will contribute to the information asymmetry mentioned earlier that emanates between parties affected by the pollutants and those causing them. Even in the case of the Philippines, such lack of extensive data is a main problem in properly studying the whole plastic waste generation problem as well as identifying policies and programs to abate the effects of the plastic waste in the environment (GAIA [2019]). Data generation is very important to aid in technical and scientific research, and in this case, reduction of plastic pollution (Barnes [2019]).

Alternative to the Coasean Solution

Until recently, there are significant moves from private sector and governments in order to collectively aid in cleaning up the environment, particularly the oceans. Of particular interest on the side of private institutions is the creation and premium pricing of goods that promote the betterment of society (of which recently a lot of products manufactured are tagged as “eco-friendly”, “recyclable”, organic”, to name a few) (Abueg, et al. [2014]).¹⁰ It is not an easy task to determine the appropriate private pricing of such goods and the revelation of the desired quantity consumed by individuals or households, due to the inherent characteristics of the public goods. As Myles (2001) discussed, such is complicated by the fact that public goods may have properties of free disposal. Myles (2001) even highlights the problem of incorrect revelation of true willingness to support public goods provision (Bohm [1971, 1972, 1984]), as well as the “free rider problem” (Johansen [1977]). This is being exacerbated if public goods become transnational (Abatayo, et al. [2017]).¹¹ Perman, et al. (2003) suggests that to ensure that such global public goods be provided, enforceable international agreements must be put in place.

Localized Solutions in Philippines addressing plastic wastes

¹⁰ Some examples of these products are the reusable metal straws, biodegradable toothbrushes (made of bamboo sticks), wooden utensils, among others. A company producing soaps (Lush) has launched their line of “naked products” (soaps without packaging), picking up the results of the report of Pennington (2016).

¹¹ Abatayo, et al. [2017] have highlighted the usual limitations of experiments in doing generalizations to analysis of these type, which is also the stand of the discussion in Myles (2001) citing the work of Bohm (1971, 1972, 1984).

Such problems of plastic waste generation across territories may be analyzed on a smaller scale: confining to the problems of territories sharing bodies of water such as seas or oceans within a country that shares a similar set of national and local policies. We examine the problems of ocean clean-up and how problems on plastic waste generation are addressed, in the case of the Philippines.

A necessary requirement in carrying out programs and policies are extensive data and relevant sources of information. Sadly, as mentioned by GAIA (2019), there is no available data extensively measuring the production of plastic waste in the Philippines. Moreover, the 2012 to 2016 data from the National Solid Waste Management Commission (NSWMC) only indicates solid waste generation per geo-political region (from Region I to NCR), sources of waste (e.g., industrial, residential, commercial), and the broad types of solid waste (e.g., biodegradables, recyclables, residuals, hazardous) (SEPO [2017]). There is no available data on the amount of plastic waste that may be identified from such report.

Nevertheless, it may be argued that solid waste generation may be a byproduct of increased economic activity (measured by the gross domestic product or GDP), and population density. This may be gleaned from data from the NSWMC on solid waste management, as well as data from the Philippine Statistics Authority on population and regional gross domestic product (RGDP). Table 1 below indicates only data on Regions III, IV-A (CALABARZON), and the National Capital Region (NCR), which are the top three regions in term of population, regional gross domestic product, contribution to GDP, and solid waste management generation.

| Region | Solid waste tons per day (2012-16), average | Regional GDP (2018), in percent | Contribution to GDP (2018), in percent | Population (2018), in million |
|--------------------|--|--|---|--------------------------------------|
| III | 3,761.1 | 7.1 | 9.8 | 11.6 |
| IV-A | 4,293.2 | 7.3 | 17.0 | 14.9 |
| NCR | 8,907.2 | 4.8 | 36.0 | 13.1 |
| Philippines | 38,757.5 | 6.2 | 100.0 | 106.6 |

Table 1. Average solid waste generated (2012 to 2016); regional GDP, contribution to GDP, and population (2018). Data from NSWMC (reported in SEPO [2017]), and PSA (2019). Averages are author's calculations.

It is also important to note that these regions are adjacent to bodies of water that are heavily polluted (Manila Bay, Laguna de Bai, and Pasig River). Note that in terms of solid waste management, there are other agencies that are tasked to safeguard the

environmental health of these bodies of water, as well as to regulate economic activities that may potentially pollute these bodies of water.¹²

In December 2000, the Philippine Congress passed the Solid Waste Management Act (Republic Act no. 9003 [RA 9003]), which mandates various mechanisms of solid waste management and reduction. One particular provision of RA 9003 is the segregation of wastes and provision of recycling facilities. However, as being argued in the Philippine setting, some of the laws are not implemented to its full extent, due to constraints in resources, or other administrative bottlenecks¹³. As an example, the National Solid Waste Management Commission in 2018 indicated that there are only 943 material recovery facilities (MRFs) servicing about 964 barangays in Metro Manila, which is 56.71% of the 1,700 estimated number of barangays in Metro Manila (Teves [2018]).

Much of the facilities for solid waste management and reduction have been created by law (i.e., material recovery facilities) in entities generating wastes (both the private and the public sector) as well as pertinent government agencies for the implementation of the provisions of RA 9003 (headed by the Department of Environment and Natural Resources [DENR]). However, there are arguments showing that such law did not lead to a change in mindset of citizens in proper waste segregation. Such is even manifested by the creation of local legislations mandating the total ban of plastic use in a lot of local government units, particularly in Philippine urban centers¹⁴.

A lot of cities in the Philippines have banned the use of plastics particularly in retail, food packaging and service, and goods delivery (dry goods and semi-expendable equipment). For instance, the local government of Quezon City instituted a Php2.00 per plastic bag used in retail outlets and businesses (e.g., groceries) that will constitute the so-called “green fund”.¹⁵

¹² Agencies that have solid waste management functions covering these bodies of water are the Metro Manila Development Authority, the Laguna Lake Development Authority, and the Pasig River Rehabilitation Commission.

¹³ In the *ADB Materials Recovery Facility Tool Kit* (ADB [2013]), it recognized that problems of proper recovery, treatment, or disposal of waste in general adds burden to current resources and capacity to properly implement solid waste management programs, both in levels of the national and local governments in many parts of Asia and the Pacific.

¹⁴ Although a paper by Sapuay (2014) have presented salient points in favor of RA 9003 (Official Gazette of the Philippines [2001]), an evaluation study done by Premakumara, et al. [2014] in Cebu City, Philippines have shown that one of the important elements for successful implementation of RA 9003 is an ensured and consistent political commitment.

¹⁵ Dasal and Mostrales (2015) have documented that in the case of Quezon City, the accumulated money for the “green fund” was not efficiently utilized by the city government, and to some extent was not mobilized for environment-related activities of the city. Although it may be argued that such implementation of a fee may have reduced the use of plastic bags in groceries (coupled with the promotion of using recyclable cloth bags), a report by the Economist (2017) has argued that the additional charge for use of plastic bags have reduced significantly the demand of these plastics (e.g., in Denmark, Ireland).

Business groups, particularly those producing these materials and those dependent on these as their inputs to their business operations, have counterargued that the paper packaging as alternative to plastics and styrofoam are costlier and would require trees to be cut down to produce paper. In addition, Bell and Cave (2011) argued that paper bags and cloth bags that are aimed to substitute for plastic, may be less worrisome in terms of contributing to sewage clogging and later flooding in urban areas. However, the energy and resource requirements are even higher and may even be more toxic when disposed in the production of such materials. Although this resistance from affected producers of plastics and styrofoam (as convenient material for food and packaging of goods) were much pronounced in the beginning, several government units were not threatened to fully enforce their respective local laws¹⁶.

It may be argued that the local laws and national policies enacted regarding solid waste (and plastic waste) generation are responses to recurring urban problems of flooding, as well as cases of solid waste accumulation in water tributaries in city centers during heavy rains. Bonanno and Orlando-Bonaca (2018) even argued that there is really a major work to be done in filling the gap on what we know about the implications of plastics that are ultimately being brought to oceans, as well as the current state of technology, policy, and actions society do in relation to mitigating plastic pollution.

Some way forward for Philippines towards ocean clean-up

Ocean plastic waste accumulation problem is not as straightforward as just cleaning the oceans from marine litter. The complexity of the marine ecosystem, the information requirements for cleanup to be implemented, the resources needed for this to be done, and most of all willingness of people to agree to contribute and participate in this endeavor are all equally important considerations.

It is also noteworthy to mention that resources devoted in clean-up have opportunity costs and economic implications. Firstly, the question of who should shoulder the payments to clean-up, and secondly, how long should this be done, given limited resources. And the most important question that remains unsettled is that whether there be a significant improvement on environmental quality after pursuing ocean clean-up or plastic waste reduction.

Economic literature has provided arguments that clean-up of oceans translate to a provision of public good, since the benefits transcend political boundaries (Myles [2001];

¹⁶ A particular case is in Baguio City, Benguet, where the legislation of plastic ban (called the "Bayong Ordinance") was only implemented after ten years, through the so-called "recycling of the old law" through amendments and revisions and now as the "Plastic- and Styrofoam-Free Baguio Ordinance" (Cimatu [2017]).

Perman, et al. [2003]). Thus, provision becomes more complex with varying effects on affected areas different stakeholder groups who have varying willingness to contribute for the provision of such global (or transnational) public good.

A remarkable recent discovery towards a solution to plastic accumulation is on the so-called “plastic eating enzyme” (Austin, et al. [2018], cited in Dockrill [2018]). This is intended to decompose the one of the mostly-used form of plastics as containers: the PET. Another promising discovery is the capability of the wax worms (*Galleria mellonella*) to decompose plastics (Bombelli, et al. [2017], cited in Arnold [2017]). In this study, it was verified that some bacteria in the gut of the wax worms (or larva) are the ones responsible for the decomposition of plastic. These findings are similar to the enzymes discovered in Austin, et al. (2018). These two discoveries have not been implemented on a mass-scale, given that such discoveries are relatively new, and that the rate at which these species can be cultured may not yet be enough to compensate the rate at which the world generates plastic waste.

It must be emphasized that there must be adequate and proper collection of data for future policy research and program implementation to correctly address problems associated with plastic waste accumulation in oceans and similar bodies of water. The current state of policies on the Philippines lack disaggregated data on types on solid waste generated, particularly on single-use plastic bags and PET bottles. Thus, the recourse of many local governments is to adapt a total ban on plastic products (e.g., on use of plastic bags, plastic utensils and straws, PET bottles).

Such ban on plastic use (also adapted in many parts of the world) seemed to be popular among local government units and city centers of the Philippines. However, as argued by those opposing the total ban of plastic use, the alternatives to plastic pose possibly more harm and costs than the envisioned benefits. Despite significant opposition, local governments have managed to implement such ban in their respective areas. Note that much of the local governments that implemented total plastic ban are located in NCR, which is the highest solid waste-generating region and have high population and economic activity (as seen in Table 1). Given that there has been identified top contributing regions on solid waste (and possibly bulk of which are plastic waste), a more careful data collection and planning must be implemented on these regions. It may be argued that such plans and programs are necessary given the intensity of economic activities and relative population densities, as well as there are available resources for local governments to implement such programs in these areas.

There might be some cultural and behavioral factors to consider for the effectivity of policies aimed to reduce plastic waste in the Philippines. Firstly, perhaps is the differentiated view on plastics as a good. In behavioral economics literature, the propensity to dispose goods depends on the relative durability of such goods in question (Antonides [1990]). Filipinos propensity to salvage or recycle such products increases when such goods are considered durable. Most do not right away throw

durable plastic: they clean it and save it for future use (e.g., plastic bags, kitchen utensils, PET bottles used as garden pot containers, novelties, and as dipper or *tabò*¹⁷).

Another way forward is the pay-for-use system of plastic bags implemented by Quezon City through a local ordinance. It might be imperative to direct such pay-for-use system towards relatively lower plastic bags that are used in wet markets. These materials are likely to be disposed more than those of higher quality in commercial and airconditioned supermarkets). In addition, it may be possible to incentivize the use of alternatives (particularly that recent businesses promote the use of cloth bags). As an example, to increase use and demand for such alternatives, shoppers may be given discounts for use of cloth bags or more durable paper bags, instead of the available plastic bags.¹⁸ A case study done in Malaysia by Asmuni, Hussin, Khalili, and Zain (2015) shows that implementing a “bag tax”¹⁹ only results to 52.3% effectiveness in reducing the use of plastic bags for shopping. They added that to increase its effectivity, awareness and education of the general public is much necessary. A notable success story is in Ireland, where stakeholders were consulted on the proper rates levied to plastic use (Convery, McDonnell, and Ferreira [2007]). Laskar and Kumar (2019) emphasized this need for public awareness and consultation through the combined efforts of both government institutions and nongovernment organizations.

As in Abueg, et al. (2014), the development of “common goods” (in this case those aimed as alternatives to plastic for promotion of waste reduction), may contribute to increased awareness in reducing solid waste generation (more particularly, the substitution of plastic products into more environmentally-friendly and biodegradable inputs). Apart from such initiatives of the private sector, it is also important that there is a shared commitment by the government in mitigating solid waste generation and looking for biodegradable alternatives to plastic and other nonbiodegradable products, both in the national government and in local government units. In this way, there is an ensured political commitment from both local and national levels of the government, which is in line with local legislation as well as in RA 9003. Also, the resolution of the plastic pollution problem lies with the people who use them. And of course recycling is part of the solution, since they argue that its the people who pollute, and not the plastic material themselves (Kienner [2010]).

References:

¹⁷ Tan (2011) argues that the “dipper” translation of the Filipino (Tagalog) word *tabò* may be regarded as weak.

¹⁸ As a particular example, ShoeMart groceries allot some points in their rewards card system for shoppers who will bring their own bags when they buy their groceries. Such accumulated points contribute to the accumulated points of respective customers enrolled in the rewards system, which may be later used to avail some discounts or other free items offered by the establishment.

¹⁹ A “bag tax” is an additional payment for the use of plastic bags when authorities declare a no-plastic day use, or when the government allows for the use of plastic bags but intends to discourage such use. The former is the case of Malaysia, and the latter is in the Philippine setting.

- Abatayo, A L, L Svenningsen, and B Thorsen [2017]. "The provision of transnational and intergenerational public goods". *Monograph article*.
- Abueg, L C, M M R Sauler, and B L Teehankee [2014]. "Toward a common good model of the firm". *DLSU Business and Economics Review* **24**(1): 1-12.
- ADB [2013]. *Material Recovery Facility Tool Kit*. Manila: Asian Development Bank. Retrieved from <https://www.adb.org/sites/default/files/publication/30220/materials-recovery-facility-tool-kit.pdf>
- Antonides, G [1990]. "Psychological factors in the lifetime of a durable good". *Royal Netherlands Academy colloquium on the Timing of Consumption and the Consumption of Time*. Amsterdam, Netherlands: Digital Web Centre for the History of Science in the Low Countries. Retrieved from <http://www.dwc.knaw.nl/DL/publications/PU00010326.pdf>
- Arnold, C [2017]. "This bug can eat plastic. But can it clean up our mess?" *National Geographic*. Retrieved from <https://news.nationalgeographic.com/2017/04/wax-worms-eat-plastic-polyethylene-trash-pollution-cleanup/>
- Asmuni, S, N B Hussin, J M Khalili, and Z M Zain [2015]. "Public participation and effectiveness of the no plastic bag day program in Malaysia". *Procedia: Social and Behavioral Sciences* **9**: 328-340.
- Austin, H, M Allen, B Donohoe, N Rorrer, F Kearns, R Silveira, B Pollard, G Dominick, R Duman, K El Omari, V Mykhaylyk, A Wagner, W Michener, A Amore, M Skaf, M Crowley, A Thorne, C Johnson, H Lee Woodcock, J McGeehan, G Beckham [2018]. "Characterization and engineering of a plastic-degrading aromatic polyesterase". *Proceedings of the National Academy of Sciences* **115**(19): E4350-E4357.
- Barnes, P [2016]. "Bad growth vs good growth: how to protect the earth and have a vibrant, more equitable market economy". *Economics*. Retrieved from <https://economics.com/growth-protect-earth-market-economy-peter-barnes/>
- Barnes, S J [2019]. "Understanding plastics pollution: The role of economic development and technological research". *Environmental Pollution* **249**: 812-821.
- Bell, K, and S Cave [2011]. "Comparison of environmental impact of plastic, paper and cloth bags". *Northern Ireland Assembly Research and Library Service Briefing Note*, NIAR 139-11 Paper 36/11.
- Beron-Vera, F, M Olascoaga, and R Lumpkin [2016]. "Inertia-induced accumulation of flotsam in the subtropical gyres". *Geophysical Research Letters* **43**(23): 12,228-12,233.
- Bohm, P [1971]. "An approach to the problem of estimating the demand for public goods". *Swedish Journal of Economics* **73**: 55-66.
- Bohm, P [1972]. "Estimating demand for public goods: an experiment". *European Economic Review* **3**: 55-66.
- Bohm, P [1984]. "Revealing demand for an actual public good". *Journal of Public Economics* **24**: 135-151.
- Bombelli, P, C Howe, and F Bertocchini [2017]. "Polyethylene bio-degradation by caterpillars of the wax moth *Galleria mellonella*". *Current Biology* **27**(8): R292-R293.

- Bonanno, G, and M Orlando-Bonaca [2018]. "Ten inconvenient questions about plastics in the sea". *Environmental Science & Policy* **85**: 146-154.
- BPF [2014]. "A history of plastics". *British Plastics Federation*. Retrieved from http://www.bpf.co.uk/plastipedia/plastics_history/Default.aspx
- Caruana, C [2018]. "Plastic debris linked to coral disease, death". *SciDev.Net*. Retrieved from <https://www.scidev.net/asia-pacific/pollution/news/plastic-debris-linked-to-coral-disease-death.html>
- Cimatu, F [2017]. "Baguio implements plastic ban – 10 years after passing ordinance". *Rappler*. Retrieved from <https://www.rappler.com/nation/168899-baguio-plastic-styrofoam-ban-recycled-ordinance>
- Coase, R [1960]. "The problem of social cost". *Journal of Law and Economics* **3**: 1-44.
- Convery, F, S McDonnell, and S Ferreira [2007]. "The most popular tax in Europe? Lessons from the Irish plastic bags levy". *Environment and Resource Economics* **38**(1): 1-11.
- Dasal, J, and T Mostrales [2015]. "Bag It: A comparative analysis on the implementation of the plastic bag ban ordinances in Muntinlupa and Quezon cities". *Undergraduate thesis*. College of Mass Communication, University of the Philippines Diliman. Retrieved from http://iskwiki.upd.edu.ph/index.php/Bag_it_a_comparative_analysis#.WvkfmljRjIV
- Derraik, J G B [2002]. "The pollution of the marine environment by plastic debris: a review". *Marine Pollution Bulletin* **44**(9): 842-852.
- Dockrill, P [2018]. "Scientists have accidentally created a mutant enzyme that eats plastic waste". *Science Alert*. Retrieved from <https://www.sciencedalert.com/scientists-accidentally-engineered-mutant-enzyme-eats-through-plastic-pet-petase-pollution>
- GAIA [2019]. *Plastics exposed: how waste assessments and brand audits are helping Philippine cities fight plastic pollution*. Quezon City: Global Alliance for Incinerator Alternatives. Retrieved from <http://www.no-burn.org/wp-content/uploads/PlasticsExposed-3.pdf>
- Galloway, T [2015]. "Micro- and nano-plastics and human health". In M Bergmann, L Gutow, and M Klages (eds.), *Marine anthropogenic litter*. Berlin, Germany: Springer.
- Gavilan, J [2017]. "Timeline: Canada garbage shipped to the Philippines". *Rappler*. Retrieved from <https://www.rappler.com/newsbreak/iq/188654-timeline-canada-garbage-philippines>
- Geyer, R, J R Jambeck, and K L Law [2017]. "Production, use, and fate of all plastics made". *Science Advances* **3**(7). Retrieved from <https://advances.sciencemag.org/content/3/7/e1700782>
- Gorman, M [1993]. *Environmental hazards: marine pollution*. ABC-CLIO Inc, Santa Barbara.
- Hardin, G [1968]. "Tragedy of the commons". *Science* **162**(3859): 1243-1248.
- Hoornweg, D, and P Bhada-Tata [2012]. "What a waste: a global review of solid waste management". *Urban development series; knowledge papers no. 15*. Washington,

- DC: The International Bank for Reconstruction and Development (World Bank). Retrieved from <https://openknowledge.worldbank.org/handle/10986/17388>
- Inquirer Research [2018]. "Do you know: May is 'Month of the Ocean'". *Philippine Daily Inquirer*. Retrieved from <http://newsinfo.inquirer.net/986912/did-you-know-may-is-month-of-the-ocean>
- Jambeck, J, R Geyer, C Wilcox, T Siegler, M Perryman, A Andrady, R Narayan, and K Law [2015]. "Plastic waste inputs from land into the ocean". *Science* **347**(6223): 768-771.
- Johansen, L [1977] "The theory of public goods: misplaced emphasis?". *Journal of Public Economics* **7**: 147-152.
- Kienner, R [2010]. "Plastic pollution: can the world solve the plastic waste problem?" *CQ Global Research* **7**(4): 157-184. Online. Available. Internet: <http://library.cqpress.com/cqresearcher/document.php?id=cqrglobal2010070000>
- Kühn, S, Bravo Rebolledo, E, and van Franeker, J [2015]. "Deleterious effects of litter on marine life". In M Bergmann, L Gutow, and M Klages (eds.), *Marine anthropogenic litter*. Berlin, Germany: Springer.
- Laskar, N, and U Kumar [2019]. "Plastics and microplastics: A threat to environment". *Environment Technology & Innovation* **14**: 100352.
- Lebreton, L, B Slat, F Ferrari, B Sainte-Rose, J Aitken, R Marthouse, S Hajbane, S Cunsolo, A Schwarz, A Levivie, K Noble, P Debeljak, H Maral, R Schoeneich-Argent, R Brambini, and J Reisser [2018]. "Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic". *Nature Scientific Reports* **8**(4666): 1-15.
- Legarda, L [2011]. "Senate Bill 3511". *Senator Loren Legarda Official Website*. Retrieved from <http://lorenlegarda.com.ph/senate-bill-no-2759-total-plastic-bag-ban/>
- Löhr, A, H Savelli, R Beunen, M Kalz, A Ragas, and F Belleghem [2017]. "Solutions for global marine litter pollution". *Environmental sustainability* **28**: 90-99.
- Melican, N [2012]. "First to ban plastics in NCR, Muntinlupa City takes campaign further". *Philippine Daily Inquirer*. Retrieved from <http://newsinfo.inquirer.net/217655/first-to-ban-plastics-in-ncr-muntinlupa-city-takes-campaign-further>
- Myles, G [2001]. *Public economics*. 2e. United Kingdom: Cambridge University Press.
- Newman, S, E Watkins, A Farmer, P Brink, and Schweitzer J [2015]. "The economics of marine litter", in: Bergmann M, L Gutow, and M Klages (eds). *Marine Anthropogenic Litter*. Springer, Cham.
- Official Gazette of the Philippines [2001]. *Republic Act number 9003*. Retrieved from <http://www.officialgazette.gov.ph/2001/01/26/republic-act-no-9003-s-2001/>
- Paquiz, L [2013]. "House Bill 3511". *House of Representatives, Philippines (archives)*. Retrieved from http://www.congress.gov.ph/legisdocs/basic_16/HB03511.pdf
- Parker, L [2018]. "Planet or Plastic?" *National Geographic*. Retrieved from <https://news.nationalgeographic.com/2017/07/plastic-produced-recycling-waste-ocean-trash-debris-environment/> (December).

- Pennington, J [2016]. "Every minute, one garbage truck of plastic is dumped into our oceans. This has to stop". *World Economic Forum*. Retrieved from <https://www.weforum.org/agenda/2016/10/every-minute-one-garbage-truck-of-plastic-is-dumped-into-our-oceans/>
- Perman, R, Y Ma, J McGilvray, and M Common [2003] . *Natural resource and environment economics*. 3e. London, United Kingdom: Addison-Wesley.
- PlasticsEurope [2013]. "Plastics–the facts 2013". *Association of Plastics manufacturers*. Retrieved from www.plasticseurope.org/Document/plastics-the-facts-2013.aspx?FolID=2.
- Premakumara, D, A Canete, M Nagaisihi, and T Kurniawan [2014]. "Policy implementation of the Republic Act (RA) No. 9003 in the Philippines: a case study of Cebu city". *Waste Management* **34**(6): 971-979.
- Press Association [2018]. "Government sets aside £60m to fight scourge of plastic waste". *The Guardian*. Press article. Retrieved from <https://www.theguardian.com/environment/2018/apr/14/government-sets-aside-fund-to-fight-plastic-waste-oceans>
- PSA [2019]. "All regional economies grow in 2018". *Philippine Statistics Authority*. Press Release. Retrieved from <https://psa.gov.ph/regional-accounts/grdp>
- Sainte-Rose, B, L Lebreton, J de Lima Rego, F Kleissen, J Reisser [2016] . "Multi-scale numerical analysis of the field efficiency of an ocean plastic cleanup array". *Proceedings of the ASME 2016 35th International Conference on Ocean, Offshore and Arctic Engineering (OMAE 2016)*, Busan, Korea.
- Sapuay, G [2014]. "Ecological Solid Waste Management Act of 2000 (RA 9003): a major step to better solid waste management in the Philippines". *Monograph*. Retrieved from https://www.researchgate.net/profile/Grace_Sapuay/publication/237584037_Ecological_Solid_Waste_Management_Act_of_2000_RA_9003_A_Major_Step_to_Better_Solid_Waste_Management_in_the_Philippines/links/02e7e52d8deecb3ec1000000.pdf
- Sesini, M [2011]. "The garbage patch in the oceans: the problem and possible solutions". *Master's thesis*. Earth Institute, Columbia University.
- SEPO [2017]. *Philippine Solid Wastes at a glance*. Pasay City: Senate Economic Planning Office. Retrieved from https://www.senate.gov.ph/publications/SEPO/AAG_Philippine%20Solid%20Wastes_Nov2017.pdf
- Tan, M [2011]. "Tabò culture". *Philippine Daily Inquirer*, opinion article. Retrieved from <https://opinion.inquirer.net/5401/'tabo'-culture>
- Teves, C [2018]. "DENR eyes more recycling facilities in Metro Manila". *Philippine News Agency*. Retrieved from <https://www.pna.gov.ph/articles/1048865> (23 September).
- The Economist [2015]. "Single-use refuse: the humble, horrible plastic bag". *Economist.com*. Video documentary. Retrieved from <https://www.economist.com/news/international/21670516-over-trillion-plastic-bags-are-used-every-year-does-charging-them-help-single-use-refuse>

US EPA [2011]. "Municipal solid waste generation, recycling, and disposal in the United States: Facts and figures for 2010". *US Environmental Protection Agency*. Retrieved from www.epa.gov/solidwaste/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf

US FDA [2015]. "The microbead-free waters act: FAQs". *US Food and Drug Administration, US Department of Health and Human Services*. Retrieved from <https://www.fda.gov/Cosmetics/uidanceRegulation/LawsRegulations/ucm531849.htm>

Wright, S, R Thompson, and T Galloway [2013]. "The physical impacts of microplastics on marine organisms: A review". *Environmental Pollution* **178**: 483-492.